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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B29C 44/30, C08J 9/12	A2	(11) International Publication Number: WO 98/23429 (43) International Publication Date: 4 June 1998 (04.06.98)

(21) International Application Number: PCT/EP97/06555

(22) International Filing Date: 24 November 1997 (24.11.97)

(30) Priority Data:
MI96A002478 27 November 1996 (27.11.96) IT
MI96A002599 11 December 1996 (11.12.96) IT

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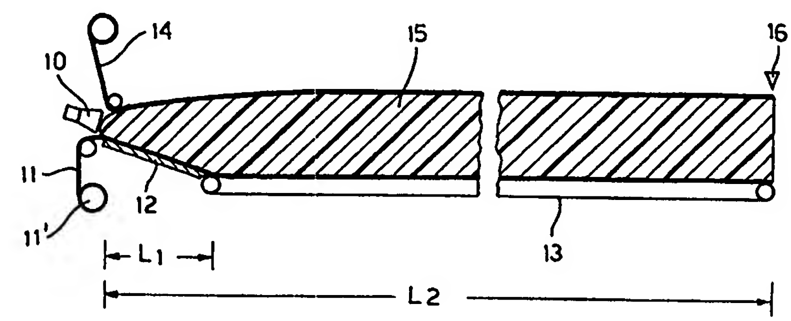
(81) Designated States: CN, JP, NO, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

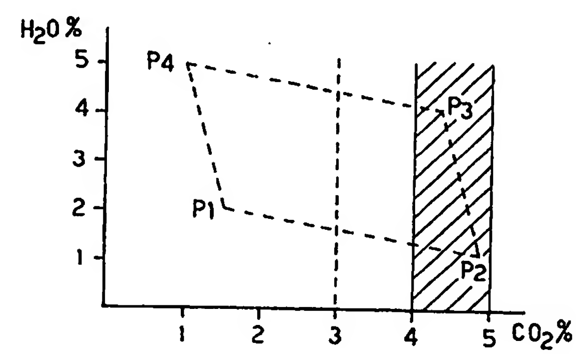
Published
Without international search report and to be republished upon receipt of that report.

(54) Title: PROCESS AND LOW-OUTPUT PLANT FOR THE CONTINUOUS PRODUCTION OF SLAB-STOCK FOAM

(57) Abstract

A process and a low-output plant (10, 12, 13) for the continuous slab-stock foam. An MDI-based chemical component is mixed with a polyole and carbon dioxide (CO_2) and the frothed mixture is delivered on a substrate (11) moving toward a slab-stock cutting zone (16). The quantity of carbon dioxide (CO_2) is kept at a value greater than 1 %, preferably within 1.5 and 5 % in respect to the polyole component to have an intensive frothing avoiding underrunning of the foam. Changing formulation, the quantity of CO_2 is kept to a substantially constant value whereas water varies depending on the total expansion index and the required density of the foam. It is so possible to use a small sized and low-output plant pre-assembled in standard containers in the form of operative units, to produce foams of different densities.





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PROCESS AND LOW-OUTPUT PLANT FOR THE CONTINUOUS PRODUCTION OF SLAB-STOCK FOAM

BACKGROUND OF THE INVENTION

The present invention relates to a process and to a low-output plant for the continuous production of polyurethane slab-stock foams.

PRIOR ART

In the continuous production of polyurethane slab-stock foams, as currently practised, a liquid mixture is continuously distributed on a moving substrate running on a downwardly slanted surface, forming a small angle of about 12° for example, with respect to a horizontal conveyor, and which extends over a substantial length of about 5 or 6 metres; the mixture is then allowed to foam and freely rise as a result of the carbon dioxide generated by the chemical reaction between the polyurethane components and water, as the foam moves and cure along a horizontal path. Plants of this kind are extremely costly, bulky or space consuming and suitable only for high production outputs.

In order to improve the quality of the polyurethane foam, EP-A-0 645 226 proposes the use of CO_2 or liquid carbon dioxide as blowing agent, in order to froth the polyurethane mixture as it is delivered and distributed on the moving substrate, in combination with post-expansion water for the continuous production of polyurethane foam slab-stocks.

The use of CO_2 as frothing agent has proved to be useful in that it has made it possible to reduce to a large extent the dimensions and sizes of the plants, and to obtain high-quality polyurethane foams avoiding the well-known underrunning phenomenon of the liquid mixture flowing underneath the expanding foam, normally caused by an excessive inclination of a downwardly sloping surface at the beginning of the conveyor path.

Although in a plant according to EP-A-0,645,226 the high viscosity of the frothed mixture substantially eliminates the aforementioned underrunning phenomenon, in practice such a plant has proved to be less suited for low-output applications which use conventional chemical systems based on toluene diisocyanate (TDI), in accordance with the various examples cited in the same document. In practice, it has not been possible to use conventional TDI-based chemical systems in low-output plants with a low CO_2 content, having a steeply inclined surface or initial conveyor section, since the known underrunning phenomenon of the mixture would reoccur.

There exists, however, the need to have chemical systems which can be used with plants having a low-output, for example less than 100-120 kg/min, and small dimensions while operating within a wide range of variability of density and hardness of the foam; this would require substantially high content values for the auxiliary blowing agent, in order to limit flowing of the foam in the initial inclined section of the foaming path. The result is that the quantities of formulation water required to obtain a given density value of the foam, would have to be reduced

significantly. In a conventional TDI chemical system, this would involve a reduction in the hardness of the foam on account of the lower polyurea content. It would be possible, however, to restore some of the hardness by using polyol polymers; however, in the case of high-density foams low levels of formulation water would result in low reactivity and process difficulties.

OBJECTS OF THE INVENTION

The main object of the present invention is to provide a process and a plant for the continuous production of open-cell polyurethane slab-stock foam, able to overcome the drawbacks resulting from the use of conventional TDI-based chemical systems and plants, so that it is possible to operate with low-output, with a plant of small sizes, by means of which a conveyor path having a steeply inclined initial surface may be used, while avoiding the underrunning phenomenon of the mixture in respect to the expanding foam.

Another object of the invention is to provide for a process and a plant as referred above, by which at the same time it is possible to maintain a wide range of variability for density and hardness values of the foams produced, while using suitable quantities of formulation water allowing high reactivity and avoiding process difficulties normally occurring with conventional process and plants.

In a traditional plant design the various parts of the plant are suitably prepared, assembled and tested at the factory, before being disassembled and separately sent to

the place of use, where the same plant must be again reassembled and thoroughly tested before being ready for use.

All this, therefore, requires a great amount of time owing to the necessary operations of assembling and pre-testing at the factory, disassembling, despatching and reassembling of the various components, in addition to subsequent testing of the plant at the place of use. All this increases considerably the overall costs, and greatly penalising the user owing to the inevitable delays in the start-up of production; furthermore the removal of the plant from the place of use is practically prevented or discouraged due to the necessity of disassembling the plant and reassembling the same in a new place of use.

Therefore an object of the present invention is to overcome the abovementioned drawbacks by providing a small sized plant of a new constructional design for continuous MDI-based slab-stock foam production, which is distinguishing over the traditional designs.

A further object of the present invention is to provide a plant of the kind referred to, for the continuous slab-stock production, which offers clear advantages over single block or batch foaming machines, as wall over conventional plants, requiring a simple and quick installation in a factory floor, by few connections to pipings and an electrical supply.

Another object of the invention is to provide a plant for the continuous slab-stock foam production, as referred to

above, having a compact design for minimum space consumption, which ensure high quality engineering, minimum transport costs and high quality foam.

BRIEF DESCRIPTION OF THE INVENTION

The above may be achieved by means of a process according to Claim 1 and by a plant according to Claim 8.

In general terms, according to a first aspect of the invention, a process has been provided for the continuous production of polyurethane slab-stock foam, in which a first isocyanate-based chemical component and a second chemical component containing active terminal hydrogen atoms such as a polyol, to react with the isocyanate component, are mixed in metered quantities and in which the resulting mixture is frothed and foamed by using in combination carbon dioxide and water in order to obtain a total expansion index which is related to a required density and hardness of the foam to produce, characterized in that the first chemical component is an MDI-based polyurethane component, including any variant, compound or reaction product thereof, for example an MDI prepolymer; and in that the resulting mixture comprises a quantity of carbon dioxide within 1 to 10%, preferably within 1.5 to 5% in respect to the second chemical component, and a metered quantity of formulation water for post-expansion until to reach the total expansion index corresponding to a specific density of the required foam.

The use of an MDI-based chemical system in accordance with the present invention, has proved to be advantageous

compared to conventional TDI-based ones since it allows the use of higher CO_2 content in percentage terms and consequently a greater viscosity of the frothed mixture which is delivered on a substrate running on the slanted surface of a fall-plate or conveyor path; consequently it is possible to use steeply inclined or downwardly slanted surfaces for the expansion of the foam, and comparatively lower conveyor speeds, operating with lower outputs and smaller sizes of the plant.

Moreover, by the tests carried out, it has been understood that MDI-based chemical systems are less dependent on the water content in order to develop the hardness of the foam; in view of the greater flexibility of the system during the tests it has in fact been possible to obtain on a same plant forms of different densities by keeping the CO_2 at a substantial constant value and by varying the formulation water content only, modifying at the same time the MDI reaction chemistry, where necessary in order to vary the rigidity of the polyurethane foam produced.

According to another aspect of the invention, a plant has been provided for the continuous production of MDI-based polyurethane slab-stock foams, in such a way as to considerably reduce the lengthwise dimensions of the plant itself, by providing a mixer and a frothing device, a fall-plate for the frothing if the mixture, conveyor means, a foam cutting device and a process control unit on a standard container, in the form of a first pre-assembled operative modular unit; while the storing tanks for chemicals and/or activators and the metering pumps are provided on a respective container in the form of a second

pre-assembled operative modular unit which have already been tested in the factory, so that the entire plant may be simply transported to the place of use already tested and ready for rapid installation, after simply performing the necessary pipework and wiring connections.

The plant for the continuous production of polyurethane slab-stock foam according to the invention may be differently constructed, depending on the specific requirements of the user, without departing from modular design and the arrangement according to the invention. Preferably may be housed and transported inside ISO standard containers which thus constitute an integral frame part of the plant itself. For example the container for the conveyor and the control unit, may comprise a framework provided on the sides with panels defining an open-end tunnel-like chamber having a length substantially corresponding to the conveyor path, in which the foaming of the mixture and polymerisation may be performed in a protected and suitably controlled environment. The panels which close on the sides the container, may be made totally or partially removable to allow access by an operator to any point of the plant during use.

BRIEF DESCRIPTION OF THE DRAWINGS

The process and a plant for the continuous production of polyurethane foam blocks according to the present invention, will be now illustrated hereinbelow with reference to the accompanying drawings, in which:

- Fig. 1 is a general diagram of the plant;

- Fig. 2 is a graph comparing the characteristics of an MDI system according to the invention, with a conventional TDI system;
- Fig. 3 is a longitudinal cross-sectional view of the first module containing the control unit and the conveyor with the associated devices;
- Fig. 4 is a top view of the module shown in Figure 3;
- Fig. 5 is a view from the right-hand end of the module according to Figure 3;
- Fig. 6 is top view of the second module comprising the metering pumps and storage tanks, inside a second container;
- Fig. 7 is a diagram of plant.

DETAILED DESCRIPTION OF THE INVENTION

As schematically shown in Figure 1, in order to implement the process according to the invention, the plant substantially comprises a lay-down device 10 for delivering an MDI-based, polyurethane mixture, which is frothed and distributed on a moving substrate 11, for example a web of paper which is continuously unwound from a bobbin 11' in a per se known manner and moved along a fall-plate 12 which is downwardly slanted towards a horizontal conveyor 13. A second web of paper 14, or plastic film, covers the upper surface of the polyurethane foam 15, while additional web of paper or plastic films, or the upwardly folded edges of the bottom paper webs 11, retain the expanding foam on both sides.

L1 in Figure 1 denotes the length of the fall-plate 12 or an initial inclined conveyor, while L2 denotes the total

length of the plant, as far as the cutting zone 16 of the slab-stocks.

According to the invention, an MDI-based chemical system is used: this term is understood as referring to any chemical system for the production of polyurethane foams, in which a first isocyanate based chemical, for example dimethyl methane diisocyanate, or any MDI variant, compound or reaction product thereof, is mixed with a second chemical component containing active terminal hydrogen atoms 70 reacting with the isocyanate, for example a polyol, and with a foaming agent able to provide the required density and hardness for the foam produced.

The foaming agent in turn consists in the combination of carbon dioxide, CO_2, able to cause an intensive frothing of the polyurethane mixture, and formulation water. In particular, the CO_2 may be pre-mixed into one of the two chemical components, preferably in the polyol, either in liquid or gas form; the resulting mixture is supplied and distributed on the moving substrate 11 by means of a frothing and delivery device 10, so as to avoid violent or rapid evaporation of the CO_2 in the polyurethane mixture, allowing in this way gradual frothing of the mixture along the fall-plate 12, followed by a foaming phase involving post-expansion of the frothed mixture caused by the formation of carbon dioxide from the chemical reaction between the chemical components and the same formulation water contained in the formulation.

As mentioned above, Figure 1 illustrates the basic concept of the plant which operates in accordance with the process of the invention. The plant in Figure 1 has been designed

for a relatively low production output and very small overall dimensions, in relation to its specific use with a polyurethane mixture based on MDI formulation in accordance with the principles of the invention.

By way of example, a plant according to the invention may have the dimensions and operational parameters indicated below:

- Length of the fall-plate	L1 = 1.2 - 2 metres
- Total length as far as cutting point	L2 = 8 - 30 metres, preferably 10-15 metres
- Total chemical output	Q = 40 - 120 kg/min.
- Conveyor speed	V = 0.5-2.5 metres/min.
- Minimum time to cutting	T = 6 minutes
- Maximum sizes of slab-stocks widthwise and heightwise	W/ht = 2.2 x 1.2 metres

Obviously these values are intended purely by way of an example of the general features of a plant designed to operate with a process according to the invention.

With reference to Figure 2, we shall now describe in greater detail the fundamental features of the invention, comparing the use of an MDI-based chemical system in accordance with the claimed process, with the use of a traditional TDI-based chemical system.

In Figure 2 the graph represented by the broken lines P1, P2, P3 and P4 shows the variability range of the percentages of water (H_2O%) and carbon dioxide (CO_2%) which can be obtained in a traditional TDI-based formulation.

In a normal TDI formulation system, the density of the foam is regulated by the total expansion index, consisting of a numerical value which represents the theoretical expansion of the foam due to the combined effect of the water and the CO_2, as foaming agents, expressed as water equivalent in percentage parts, compared to the polyol, taken as 100. The hardness of the foam, on the other hand, is regulated by varying the proportions of water and CO_2, keeping the total expansion index at a constant value for a same density; in general, hard foams are obtained by increasing the percentage of water and reducing CO_2, while soft foams are obtained by reducing the water and increasing the percentage of CO_2.

From Figure 2, it can be noted therefore, that the zones close to the points P1 and P4 relate to foams with high densities and varying hardness as a result of the reduced percentage of CO_2 and the varying formulation water content. Similarly, the points P2 and P3 relate to foams with an average density and varying hardness as a result of the increased percentage of CO_2 and the varying water content. In all cases, with these conventional systems, for a given density value of the foam to be produced, the percentage ratios of water and carbon dioxide will vary in each case, depending on the total expansion index required. In any case, in order to convert a plant for the production of foams having different densities, it will be necessary to vary both the water content and the CO_2 content for denser foams, modifying the reactivity of the system and the viscosity of the frothed foams, with consequent process difficulties.

Differently, according to the present invention, an MDI-based chemical system is used in order to obtain a wide range of variability in the density of the foam produced, using a substantially constant quantity of CO_2, greater than 1%, for the preliminary frothing stage, and varying consequently the percentage or quantity of water necessary for post-expansion, until a predetermined value of the total expansion index is obtained, depending on the required foam density.

The possibility of keeping substantially constant, at relatively high values, the percentage of CO_2 therefore allows one to use advantageously the high viscosity properties of the frothed mixture, avoiding the undesired underrunning phenomenon of the mixture underneath the expanding polyurethane foam, even with steeply inclined fall-plates; in this way it is possible to use a same low-output plant with extremely low speeds of the conveyor, for the continuous production of slab-stocks of polyurethane foams having densities lying within a high range of variability.

The following tables show some non-limiting examples of MDI-based foams within a wide density range, with CO_2 percentages corresponding to 4% and 5%.

TABLE I

	Foam density	Total expans. index -.- % water	Total expans. index for CO_2 - % equiv. water	Expans. index - water %	Total through-put for 1.5 m/min conveyor	Through-put for 1.0 m/min conveyor
4% CO_2	14	7.1	1.5	5.6	48	32
	16	6.2	1.5	4.7	63	42
	20	5.0	1.5	3.5	79	53
	24	4.2	1.5	2.7	95	63
	28	3.6	1.5	2.1	110	74
	32	3.1	1.5	1.6		84
	40	2.5	1.5	1.0		106

TABLE II

	Foam density	Total expans. index -.- % water	Expans. index for CO_2 - % equiv. water	Expans. index - water %	Output ------ 1.5 m/min conveyor	Output ------ 1.0 m/min conveyor
5% CO_2	14	7.1	1.9	5.2	48	32
	16	6.2	1.9	4.3	63	42
	20	5.0	1.9	3.1	79	53
	24	4.2	1.9	2.3	95	63
	28	3.6	1.9	1.7	110	74
	32	3.1	1.9	1.2		84
	40	2.5	1.9	0.6		106

Table I relates to the case of a mixture with 4% of CO_2, for a foam density ranging between 14 kg/m^3 and 40 kg/m^3; however, by modifying the quantity of water, the density of the foam which can be obtained could also be greater or less than that indicated.

In this Table, the first column shows the foam density values expressed in kg/m^3, the second column shows the total expansion index values, at the various densities, expressed in percentage of water; the third column shows the expansion indices relating to the percentage value of 4% of CO_2, expressed in per cent of water equivalent, while the fourth column shows the expansion indices, in per cent, of the formulation water, which can be obtained by means of the difference between the indices of the second and third column. The last two columns, on the other hand, show the average values of the outputs, with variation in the densities, for speeds of the conveyor corresponding to 1.5 m/min. and 1.0 m/min., respectively, as indicated.

Table II is similar to the preceding one, but relates to a CO_2 content of 5%, while maintaining the same MDI formulation.

Figures 3 to 7 show various views of the first module of a plant, according to the invention: the plant, as usual, comprises a mixer for delivering a polyurethane mixture, a conveyor, a slab-stock cutting device and a process control unit. More precisely, as shown, this first module comprises an open-end container 17, of the standard type, for example an ISO 40 container having a length of about 12 metres; the container 17 consists, for example, of a peripheral

framework comprising a series of uprights 18 connected at the top and the bottom sides by longitudinal beams 19, and by cross beams 19', to provide a strong frame structure for the entire container.

On both sides the container is moreover provided with closing panels 23 to define an open-end or tunnel-like chamber; the panels 23 are removably fixed to the framework so as to allow access by an operator and inspection of the plant at any point along the same container.

At one end of the container 17 there is arranged a footboard 24 for an operator, and a control unit 25 for the entire production process.

A conveyor 13 extends longitudinally inside the container 17, from a downwardly slanted plane 12, also referred to as fall-plate, for a moving substrate 11 onto which an MDI-based polyurethane mixture is delivered and suitably pre-expanded or frothed for example by using CO_2 as blowing agent; the froth is successively foamed as a result of the reaction between the chemical components and water, rising as it moves along the fall-plate. The foam then runs along a polymerisation path defined by the conveyor 13, towards the slab-stock cutting zone, at the opposite end of the container 17, where a cutting device 16 is provided. Vertical walls 20 are laterally arranged at both sides of the fall-plate 12 and the conveyor 13 for retaining the foam.

Externally, on both sides of the container 17 means are also provided for attaching rollers 21 and 22 for unwinding

and respectively for winding-up webs of paper or plastic films sliding inside and along the side walls 20, to contact the foam advancing on the conveyor 13. The winding-up rollers 22 are operated by a suitable geared motor 22'. A moving substrate, in the form of a paper sheet or plastic film 11, slides along the fall-plate 12 and the conveyor 13, being unwound from a bobbin 11′ outside the front end of the container 17; the paper web or plastic film 11 which is unwound from the bobbin 11′ passes and is guided, for example underneath the footboard 24, and then travels up towards the top edge of the fall-plate 12.

A mixing head 10′ of conventional type for the polyurethane components, is pending from a support bracket 26 fixed to a mounting plate 26′ fastened at the top wall of the container 17; the mixing head 10′ is connected to a frothing device 10, for delivering a pre-expanded or frothed mixture at the upper end of the fall-plate 12.

Reference 28 in Figures 1 and 2 denotes moreover two suction fans fixed to respective mounting plates at the top wall of the container 17, in the vicinity of the fall-plate 12 and at the midway point of the conveyor 13, for sucking up air and gases inside the said container.

Figure 6 of the drawings shows the second module for housing some of the storing tanks for the chemical component and metering pumps, which forms part of the plant according to the invention.
In the example of Figure 6, a smaller container of standard dimensions, for example an ISO 20 container, is used, said container being shown diagrammatically by the dot-dash line

30 in Figure 6. The container 30, like the container 17, also comprises a framework formed by beams, uprights and by side closing panels suitably provided with connection fittings for the pipeworks and wiring which for the connection to the various equipment of the plant.

In particular, as shown by the top view in Figure 6, this second module comprises the tanks 32, 33 and 34 for storing chemicals or activators, including the tank 31 for the formulation water necessary for chemical expansion of the polyurethane mixture, with respective metering pumps 31', 32', 33' and 34' pre-assembled with the respective control valves 36, 37, 38 and 39 and pipeworks.

The container 30 also comprises a pump 40 and a respective control valve 41 for the circulation of one of the polyurethane components, for example the MDI-based component contained in a storage tank 43 (Figure 7) outside the container 30; the container 30 also comprises two additional metering pumps 44 and 45 with respective control valves 46 and 47 for the circulation of a second and optionally a third chemical component of the polyurethane mixture, for example a first and a second polyol, each stored in a respective tank 48 and 49.

Lastly, reference 50 in Figure 5 denotes a fourth metering pump inside the container 30, with a respective control valve 51, for supplying a blowing agent, for example CO_2, stored into a tank 52 which can be located outside or in a special space accessible inside one of the two containers 17 or 30.

The general circuit diagram of the plant is shown in Figure 7 of the drawings, where the same reference numbers have been used to denote corresponding parts of the other figures. In particular, in Figure 7, reference number 53 denotes a pressure air source for supplying nucleating air directly to the mixing head 10'.

It has been said that the invention substantially resides in a modular plant for the continuous production of polyurethane slab-stock foam by using an MDI-based polyurethane mixture, according to which the plant consists of two operative modular units preassembled in housing and transportation containers of standard sizes and in which the two plant modules, together with all the operationally necessary equipment, may be tested directly at the factory site and delivered to the user ready for an operational state. The two containers and the closing panels will therefore be already provided with all the fittings for mounting the conveyor, the fall-plate and all remaining equipment. Fittings 51 are provided on both containers for connections of pipings and electrical wirings.

It is thus possible to provide a modular plant in which the equipment and/or the devices of each module are suitably pre-assembled and factory-tested; the plant may thus be transported directly in the two housing containers, ready for the use following the installation and after performing in a simple manner the necessary connections of the pipeworks and wiring between the modules as well as to the electrical supply and the outer storage tanks; the long reassembly and re-testing times at the plant site are thus entirely eliminated.

From the above description it will appear that the main feature of the invention resides in the use of an MDI-based chemical system, instead of the conventional TDI systems, for the continuous production of open-cell polyurethane foam blocks, in which a polyurethane mixture is intensively frothed by using a relatively large quantity of CO_2, to obviate the underrunning phenomenon and in which the CO2 percentage may remain substantially constant at a predetermined value, varying solely the quantity of formulation water in order to change the total expansion index value, as required for production of foams having different densities by a same small sized plant.

In this way it is possible to use low-output plants, which have extremely small dimensions compared to conventional plants, by increasing the angle of the fall-plate or corresponding sloped surface at the beginning of the conveyor path on which the frothed polyurethane mixture is deposited, and by reducing the conveyor speed without encountering the well-known process problems of plants which used TDI-based formulations. It is understood, however, that the above description and illustrations with reference to the accompanying drawings have been provided purely by way of example of the general principles of the invention.

CLAIMS

1. A process for continuous production of polyurethane slab-stock foam, in which a first isocyanate-based chemical component and a second chemical component containing active terminal hydrogen atoms to react with the first chemical component are mixed in metered quantities, and in which the resulting mixture is frothed and foamed using in combination carbon dioxide and water in the mixture, in order to provide a total expansion index related to a required density and hardness of the foam, characterized in that said first component is an MDI-based chemical component and in that the quantity of carbon dioxide is comprised between 1 and 10% in relation to said second chemical component, adding a metered quantity of formulation water up to reach a total expansion index corresponding to a required density of the foam.

2. A process according to Claim 1, characterized in that the second chemical component is diphenyl methane diisocyanate, or any variant, compound or reaction product thereof.

3. A process according to Claim 2, characterized in that the second chemical component is a prepolymer of diphenyl methane diisocyanate.

4. A process according to Claim 1, characterized in that the quantity of carbon dioxide is preferably comprised between 1.5% and 5%.

5. A process according to Claim 1, characterized in that

the carbon dioxide is premixed in the liquid state, in at least one of the chemical components.

6. A process according to Claim 1, characterized in that the carbon dioxide is premixed in the gaseous state, in at least one of the chemical components.

7. A process for the continuous production of polyurethane slab-stock foams according to the MDI-based process of Claim 1, the improvement comprising to change the formulation for a new density of the foam, by keeping the carbon dioxide quantity at a substantial constant value while changing the quantity of formulation water in the mixture to reach a new total expansion index corresponding to the new density required for the foam.

8. A modular plant for the continuos slab-stock production of polyurethane material according to the process of Claim 1, in which chemicals comprising MDI-based polyurethane components and activators are mixed by a mixer (24) and poured in a frothed condition onto a moving substrate (11) at one end of a conveyor path (12, 13), and in which the frothed mixture is allowed to foam as the same foam moves along the conveyor path (12) and towards a slab-stock cutting device (16), and a control unit (25) for the same plant, characterized by comprising first (17) and second (30) containers for housing the plant, said first container (17) being open at both ends, and comprising said coveyor path (12, 13) longitudinally extending from the mixer (10) to the cutting device (16); the conveyor path (12, 13) the mixer (10), the cutting device (16) and the control unit (25) being operatively connected and provided

on the first open-end container (17) in the form of a first operative modular unit; and in that storage tanks (31 - 34) for chemicals and/or activators and metering pumps (31'-34', 40, 44, 45, 50) are provided on the second container (30) in the form of a second pre-assembled operative modular unit, and connecting means (51) are provided on both containers (17, 30) for piping and wiring connections.

9. A modular plant according to Claim 8, characterized in that said first container (17) for the control unit (25) and the conveyor path (12, 13) is in the form of a tunnel-like chamber, having removably fastened side panels (20).

10. A modular plant according to Claim 8, characterized in that said containers (17, 30) for housing the plant are in the form ISO standard containers.

11. A modular plant according to Claim 8 characterized in that means (11', 21, 22, 22') are provided on the first container (17) for mounting webs unwinding and winding-up devices, to contain the foam along said conveying path (12, 13).

12. A modular plant according to Claim 8 characterized in that the total chemical output of the plant is ranging between 40 and 120 kg/min, the conveyor speed is ranging between 0.5 and 2.5 metres/min., and the total length of the same plant is comprised between 8 and 30 metres, preferably between 10 and 15 metres.

13. A plant according to Claim 12, characterized in that

the length of the slanted portion of the foaming path is between 1.2 and 2 metres.

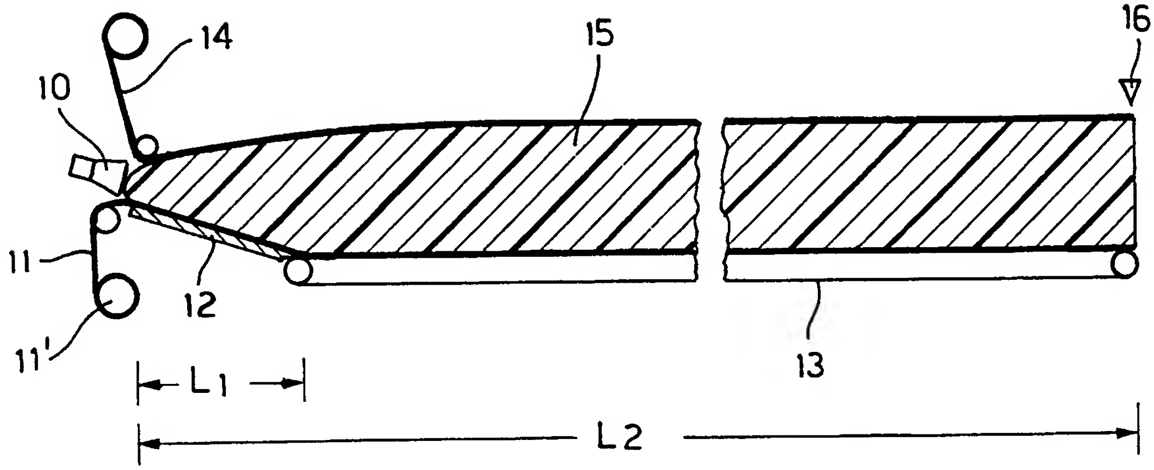

FIG.1

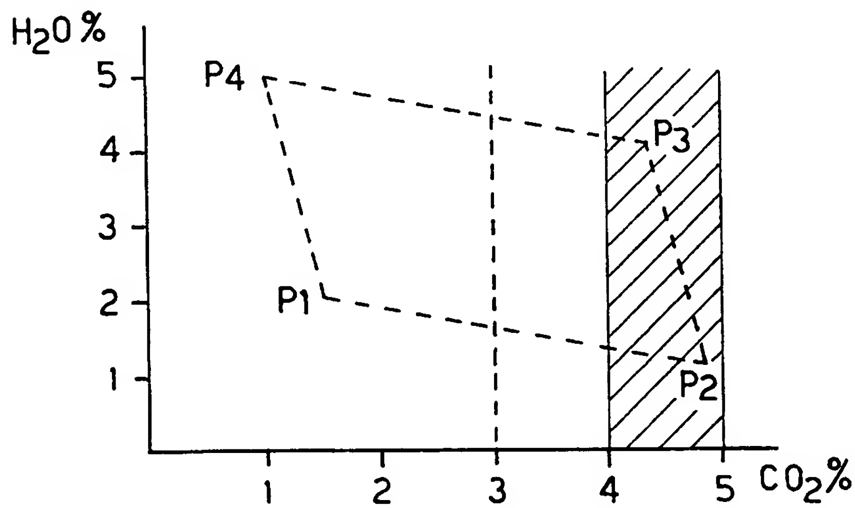

FIG. 2

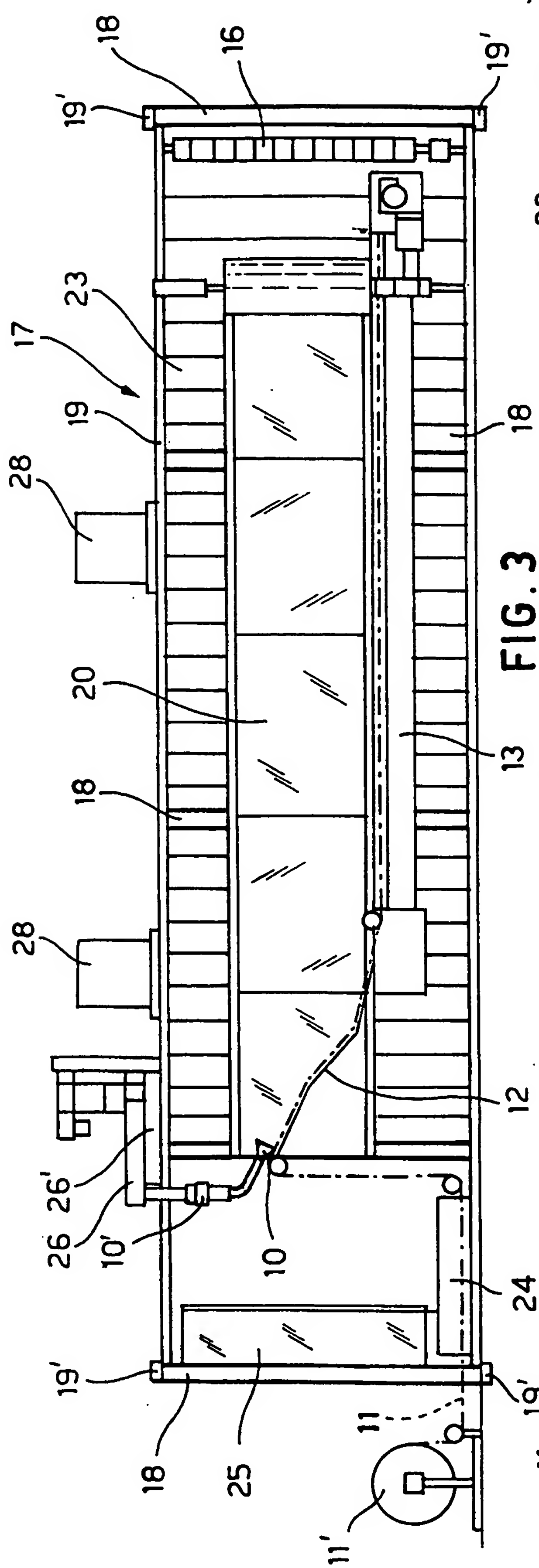

FIG. 3

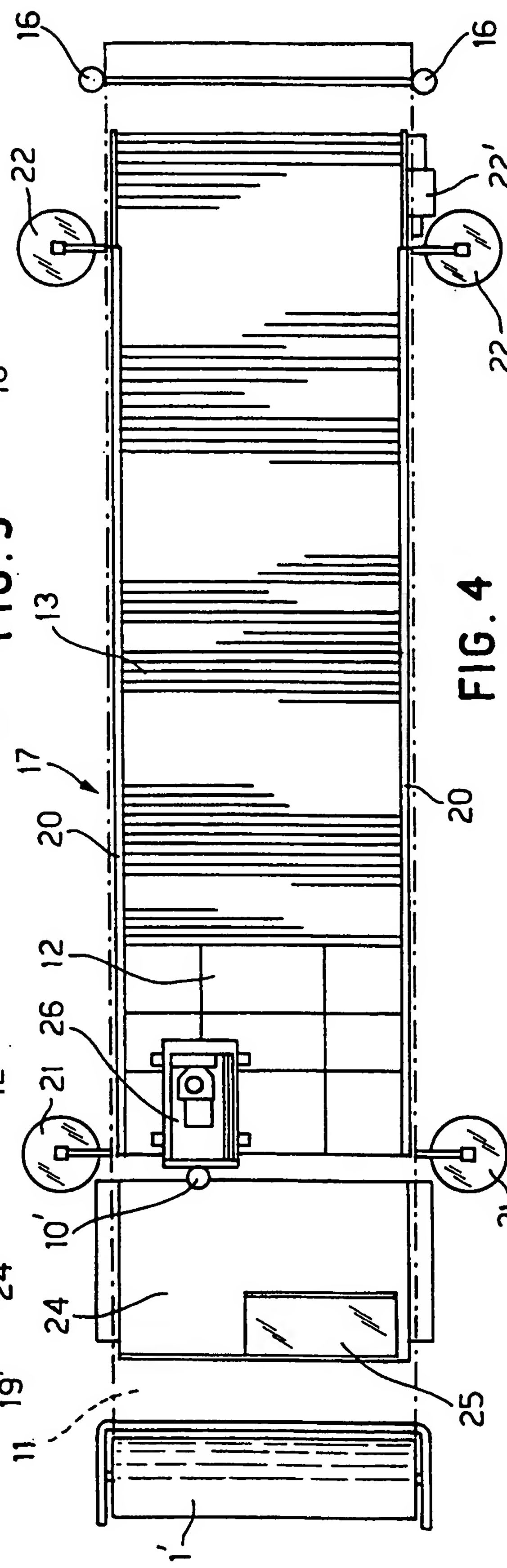

FIG. 4

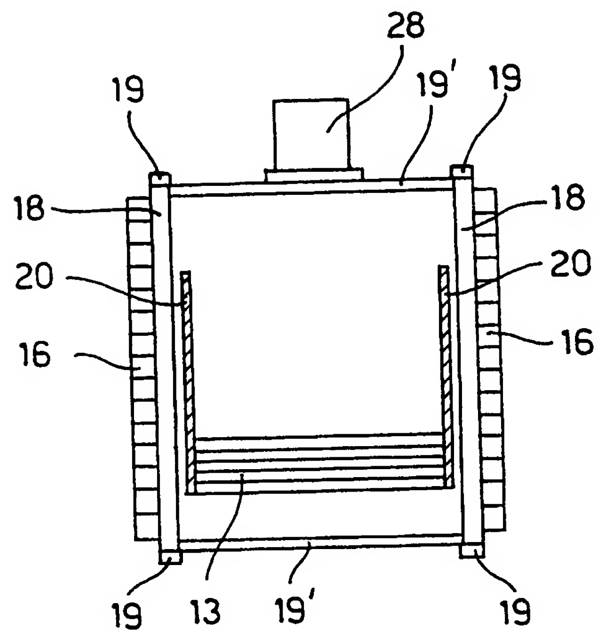

FIG.5

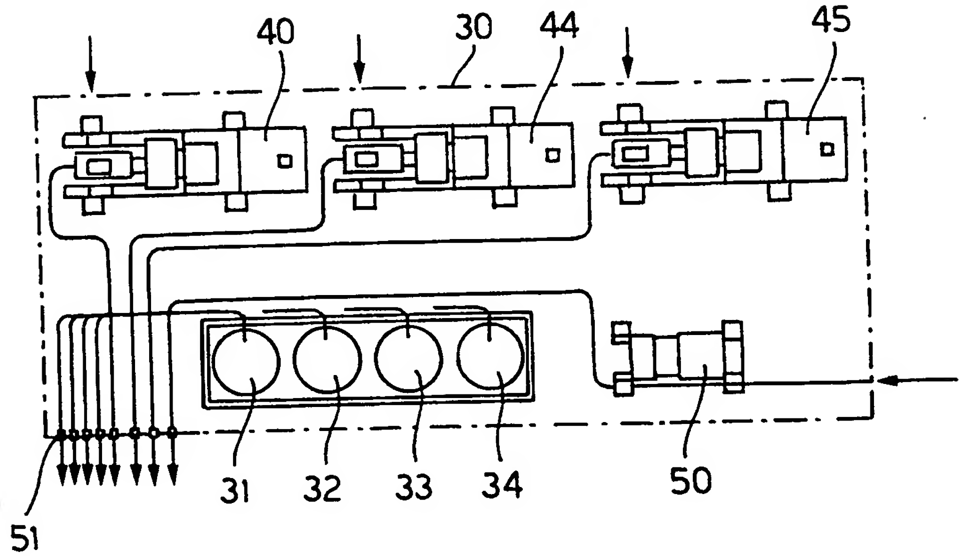

FIG.6

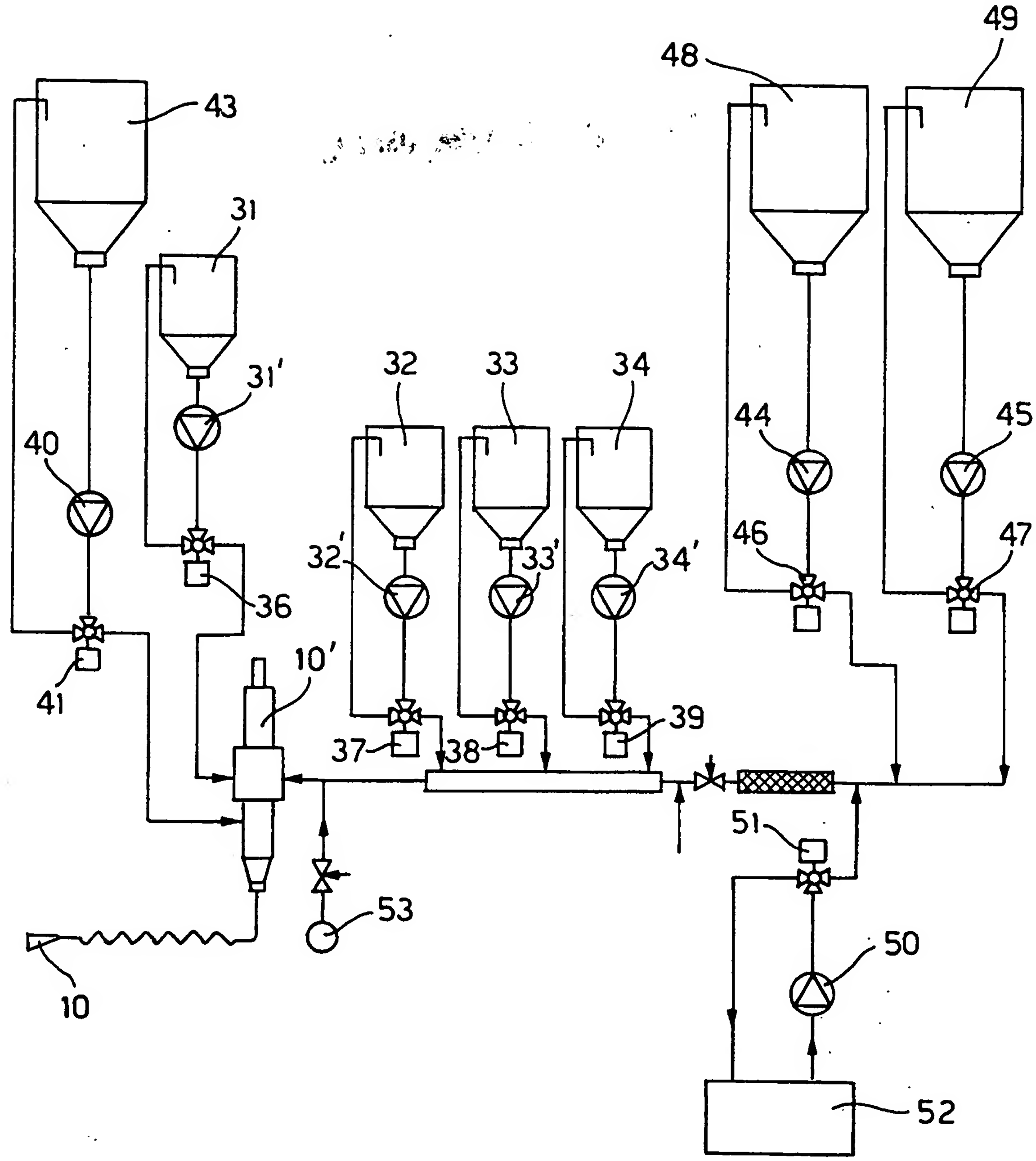
43
31
31'
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FIG. 7